

# Architecture and Design Document

*Hangout*

## Revision History

Date	Description	Author	Comments
10/14/2019	Initial Draft	Antonio Sanchez, Brandon Pitcher, Eric Curlett, Dean Vo, Ashley Williams	Initial draft of document
10/15/2019	v1.5	Antonio Sanchez	Added Scope, description, and trade-off analysis
10/16/2019	v1.9		Trade-off analysis moved to the end of document
12/09/2019	v2.0	Antonio Sanchez	Added Flux Design Pattern to Front End Architecture Details
12/10/2019	v2.1	Antonio Sanchez	Added Database trade off analysis and Architectural Pattern trade off analysis.
1/29/2020	v2.2	Ashley Williams	Machine Learning: Business Needs, Training Data, Web Service, and Model Tradeoff
3/25/2020	v2.3	Ashley Williams	Machine Learning Updates and Additions

## Document Approval

Feature Name	Printed Name	Title	Date
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# Introduction

## 1.1 Purpose

This architecture and design document is intended display the overview of implementation of *Hangout* at every level.

## 1.2 Scope

This design document is meant to provide an overview of the structure of our webapp. This document also includes the tradeoff analysis between different frameworks to choose from. UML Diagrams and Sequence Diagrams are included to show how each component interacts with each other.

## 1.3 Intended Audience

Hangout is intended as a lightweight web app that users will be able to quickly and efficiently meet with others of similar interests. Hangout is designed to be used by all types of users who might use social media, and thus must be designed to be accessible and quick over detailed and complicated.

## 1.4 Overview

Hangout will use a Decision Tree learning model inorder to serve relevant ads as well as suggestions for Hangout™s that we believe the users will likely respond well to and be interested in.

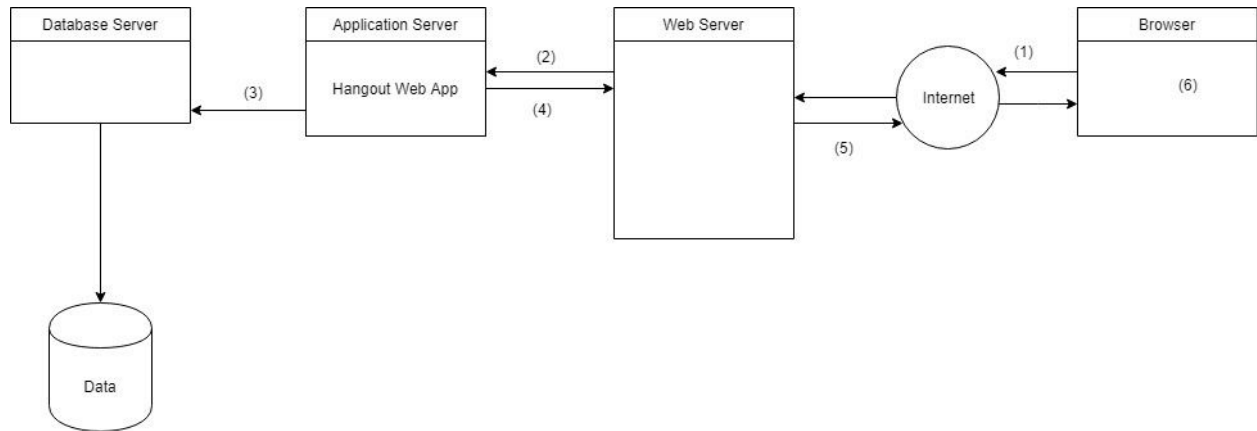
The server side code will be written in NodeJS, which is sufficiently lightweight and flexible for our needs as well as being relatively simple

We will have an Apache Web Server running a virtual console of Debian

React will be used as the front end. React is fast, scalable, and highly testable. It also is reportedly also very simple and easy to learn, which is appealing as we have limited time and capacity.

## Architecture Details

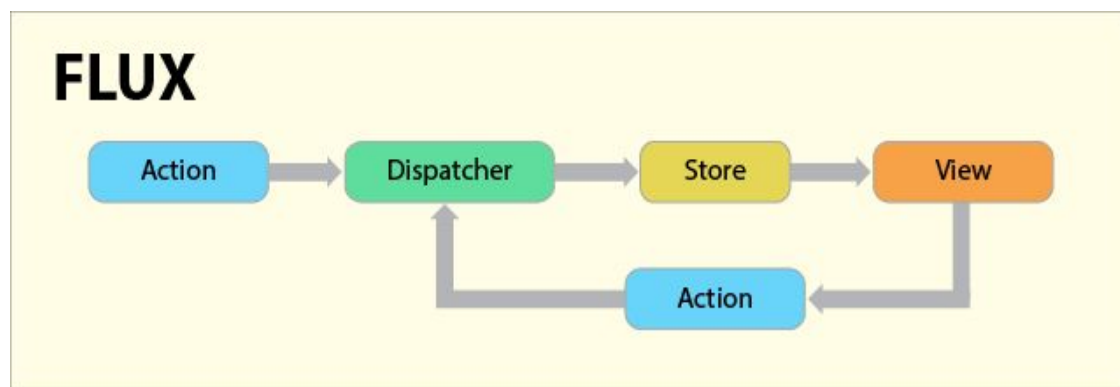
### 2.1 Top Level Architecture System Diagram



The diagram above is a block view of the *Hangout* system, displaying the different interactions between the modules. The numbered arrows show the flow of control between the modules. It behaves like a standard web app with the flow of control going from browser (1) to web server to our web app, and finally to our database server that stores our user info .

#### 2.1.1 Front End Design Diagram (Flux)

In the diagrams below, we have decided to implement the Flux design pattern for front end components of the *Hangout* webapp.



The goal is to take advantage of the more stream-lined flow of data when dealing with multiple front end components. It provides a way to attach data to views as it gets more complex. This is a pattern for managing how data flows through the React Application.

## 4 Main Components in Flux

**Actions** - Helpers that pass data to the Dispatcher

**Dispatcher** - Receives these Actions and broadcast payloads to registered callbacks.

**Stores** - Act as containers for application state & logic. The real work in the application is done in the Stores. The Stores registered to listen in on the actions of the Dispatcher will do accordingly and update the Views.

**Controller Views** - React Components grab the state from the stores and then pass it down to the child components.

The Controllers in the MVC and Flux are different. Here the Controllers are Controller-Views, and are found at the very top of the hierarchy. Views are React components. All the functionality is usually found within the Store. The Store is where all the work is done and tells the Dispatcher which events/actions it is listening for.

The Action, Dispatcher, Store and View are independent nodes with specific inputs and outputs. The data flows through the Dispatcher, the central hub, which in turn manages all the data. The Dispatcher acts as a registry with registered callbacks that the Stores respond to. Stores will emit a change which will be picked by the Controller-Views.

### 2.1.2 Code Example (Flux)

\* All code will be pushed onto our github repository. For testing purposes, code implementing flux will be branched off into *Flux* branch until it's ready to be merged with the *master* branch.

#### Without Flux:

eventList.js

```
import React, { Component, PropTypes } from 'react';
import ListItem from './ListItem';
import ListHeader from './ListHeader';
import EmptyList from './EmptyList';

class List extends Component {
  getListOfItemIds = items => Object.keys(items)
  //Need an accumulator to get current list of
  //events
  getTotalNumberOfListItems = items => (
    this.getListOfItemIds(items).reduce((accumulator, itemId) => (
      accumulator + parseInt(items[itemId].quantity, 10)
```

```
    ), 0)
  )
}
```

//list items here created but coupling is tight

```
createListItemElements(items) {
  let item;
  const { removeListItem } = this.props;

  return (
    this
    .getListOfItemIds(items)
    .map(itemId => {
      item = items[itemId];
      return (<ListItem item={item} removeListItem={removeListItem} key={item.id}
    />);
    })
    .reverse()
  );
}
```

```
render() {
  const { items, removeAllListItems } = this.props;
  const listItemElements = this.createListItemElements(items);

  return (
    <div>
      <h3 className="page-header">

        <ListHeader
          totalNumberOfListItems={this.getTotalNumberOfListItems(items)}
          removeAllListItems={removeAllListItems}
        />

      </h3>
      <ul>

        {listItemElements.length > 0 ? listItemElements : <EmptyList />}

      </ul>
    </div>
  );
}
```

```
List.propTypes = {
  removeListItem: PropTypes.func.isRequired,
  removeAllListItems: PropTypes.func.isRequired,
}
```

```
    items: PropTypes.array.isRequired,
  };

```

```
export default List;

```

## With Flux:

eventList.js

```
var React = require('react');
var ListItem = require('./ListItem');
var ListHeader = require('./ListHeader');
var EmptyList = require('./EmptyList');
var ListItemStore = require('../stores/ListItemStore');
```

```
var List = React.createClass({

  getInitialState: function () {
    return this.getList();
  },

  getList: function () {
    return {
      items: ListItemStore.getAllListItems()
    };
  },

  updateState: function () {
    this.setState(this.getList());
  },

```

**//components added to update state after Dispatcher calls  
//a store**

```
  componentDidMount: function () {
    ListItemStore.addChangeListener(this.updateState);
  },

  componentWillUnmount: function () {
    ListItemStore.removeChangeListener(this.updateState);
  },

  getListOfItemIds: function (items) {
    return Object.keys(items);
  },

  getTotalNumberOfListItems: function (items) {
    var totalNumberOfItems = 0;

```



```

    var item;

    this.getListOfItemIds(items).forEach(function (itemId) {
        item = items[itemId];
        totalNumberOfItems = totalNumberOfItems + parseInt(item.quantity, 10);
    });

    return totalNumberOfItems;
},

createListItemElements: function (items) {
    var item;

    return (
        this
        .getListOfItemIds(items)
        .map(function createListItemElement(itemId) {
            item = items[itemId];
            return (<ListItem item={item}
handleRemoveListItem={this.props.removeListItem} key={item.id} />);
        }).bind(this))
        .reverse()
    );
},

render: function () {
    var items = this.state.items;
    var listItemElements = this.createListItemElements(items);

    return (
        <div>
            <h3 className="page-header">

                <ListHeader totalNumberOfListItems={this.getTotalNumberOfListItems(items)}
/>

            </h3>
            <ul>

                {listItemElements.length > 0 ? listItemElements : <EmptyList />}

            </ul>
        </div>
    );
}
});

module.exports = List;

```

Listitemstore.js

```
var Dispatcher = require('../dispatcher/Dispatcher');
var EventEmitter = require('events').EventEmitter;
var objectAssign = require('object-assign');
```

```
var eventList = {};
```

//all stores need for list items are now stored here rather than in separate files

```
function addListItem(listItem) {
  eventList[listItem.id] = listItem;
```

```
  ListItemStore.emit('change');
}
```

```
function removeListItem(listItemId) {
  delete eventList[listItemId];
```

```
  ListItemStore.emit('change');
}
```

```
function removeAllListItems() {
  eventList = {};
```

```
  ListItemStore.emit('change');
}
```

```
var ListItemStore = objectAssign({}, EventEmitter.prototype, {
```

```
  getAllListItems: function () {
    return eventList;
  },
```

```
  addChangeListener: function (changeEventHandler) {
    this.on('change', changeEventHandler);
  },
```

```
  removeChangeListener: function (changeEventHandler) {
    this.removeListener('change', changeEventHandler);
  }
}
```

```
});
```

```
function handleAction(action) {
  if (action.type === 'add_list_item') {
```

```

    addListItem(action.item);
  } else if (action.type === 'remove_list_item') {
    removeListItem(action.itemId);
  } else if (action.type === 'remove_all_list_items') {
    removeAllListItems();
  }
}

```

**//handleAction in this file calls for the dispatcher**

```
ListItemStore.dispatchToken = Dispatcher.register(handleAction);
```

**//dispatcher stored in separate file**

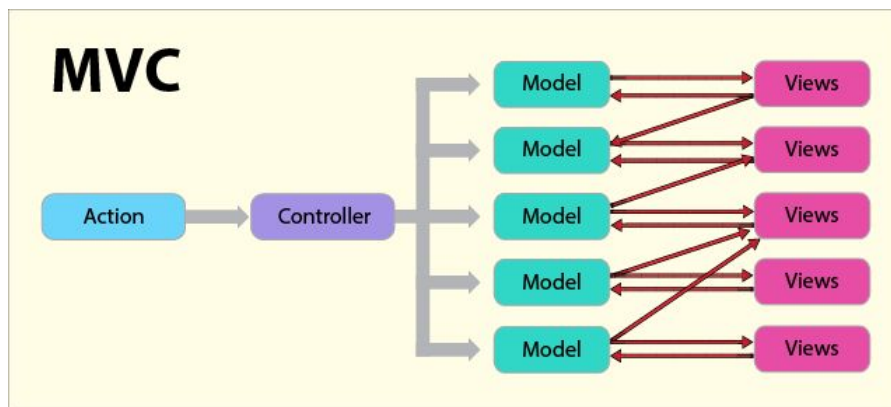
```

module.exports = ListItemStore;
var Dispatcher = require('flux').Dispatcher;

module.exports = new Dispatcher();

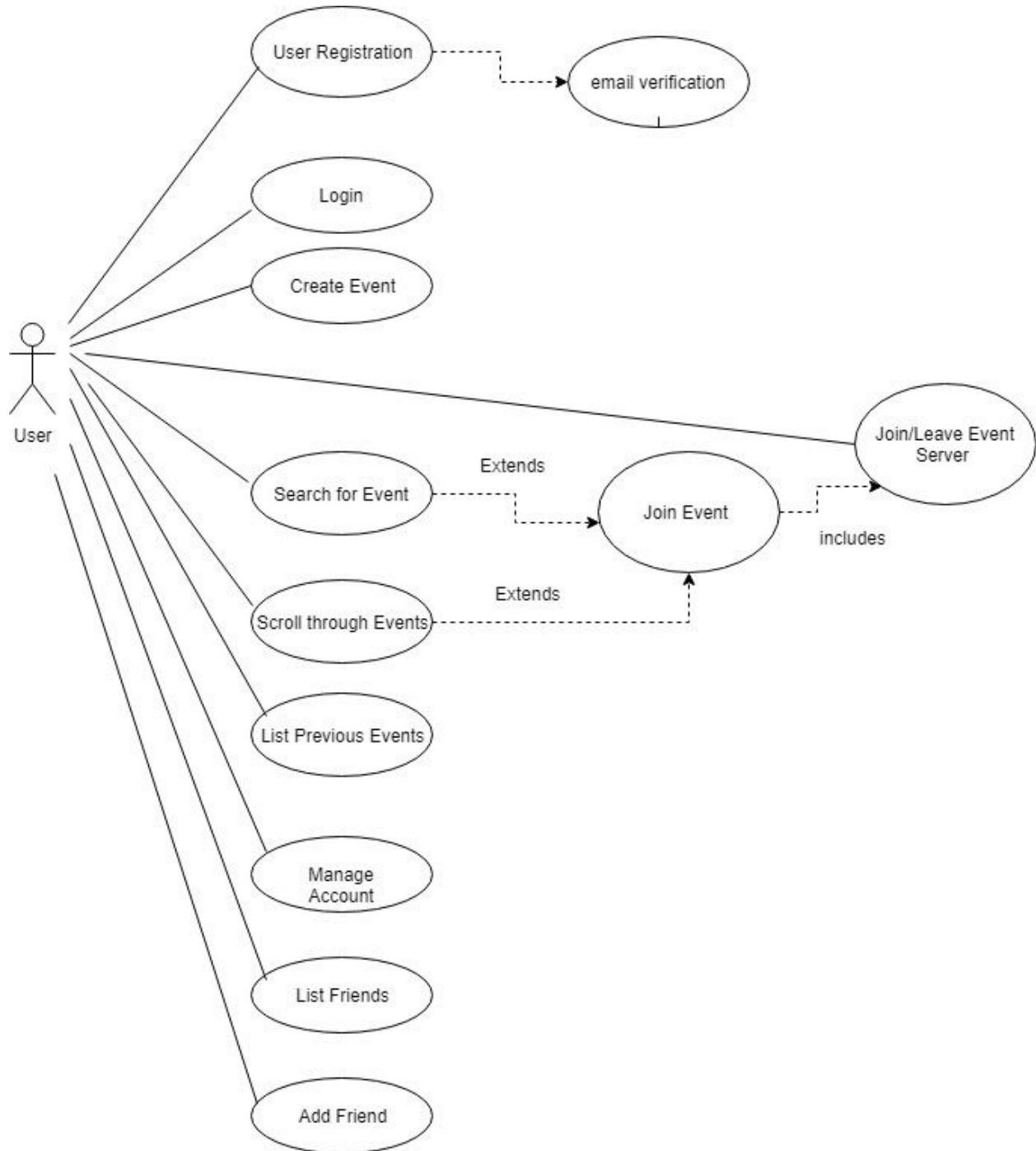
```

## 2.1.2 Back End Design Diagram (MVC)



We will be using the traditional model-view-controller design pattern for the backend architecture design. Since the flow of data is considered more rigid when moving through server and client, MVC provides an efficient way to implement our back-end components.

## 2.2 Use Cases



## **2.2.1 Use Case UC1**

### **2.2.1.1 *Objective***

Registration

### **2.2.1.2 *Priority***

High

### **2.2.1.3 *Actors***

End-User

### **2.2.1.4 *Pre-conditions***

The user is connected to the internet and navigates to the *Hangout* website on their browser.

### **2.2.1.5 *Post-conditions***

The user is now a member of *Hangout*.

## **2.2.2 Use Case UC2**

### **2.2.2.1 *Objective***

Verification

### **2.2.2.2 *Priority***

Medium

### **2.2.2.3 *Actors***

End-User

### **2.2.2.4 *Pre-conditions***

The user is registering to *Hangout* as a new user.

### **2.2.2.5 *Post-conditions***

User is now a registered user of *Hangout* and create/search for Events and update their account.

## **2.2.3 Use Case UC3**

### **2.2.3.1 *Objective***

Login

### **2.2.3.2 *Priority***

High

### **2.2.3.3 Actors**

End-User

### **2.2.3.4 Pre-conditions**

The user is connected to the internet and navigates to the *Hangout* website on their browser.

### **2.2.3.5 Post-conditions**

User signs in and has access to the *Hangout* home page.

## **2.2.4 Use Case UC4**

### **2.2.4.1 Objective**

Create Event

### **2.2.4.2 Priority**

High

### **2.2.4.3 Actors**

End-User

### **2.2.4.4 Pre-conditions**

A user is logged into *Hangout*.

### **2.2.4.5 Post-conditions**

User has posted a new Event to the site.

## **2.2.5 Use Case UC5**

### **2.2.5.1 Objective**

Search Event

### **2.2.5.2 Priority**

High

### **2.2.5.3 Actors**

End-User

### **2.2.5.4 Pre-conditions**

User logged into *Hangout*

### **2.2.5.5 Post-conditions**

User is given a list of Events that match their search criteria.

## **2.2.6 Use Case UC6**

### **2.2.6.1 *Objective***

Join Event

### **2.2.6.2 *Priority***

High

### **2.2.6.3 *Actors***

End-User

### **2.2.6.4 *Pre-conditions***

User is given an event list that matches his search criteria.

### **2.2.6.5 *Post-conditions***

User Joins an event.

## **2.2.7 Use Case UC7**

### **2.2.7.1 *Objective***

Scroll through events

### **2.2.7.2 *Priority***

Medium

### **2.2.7.3 *Actors***

End-User

### **2.2.7.4 *Pre-conditions***

User can navigate through events held on a given day.

### **2.2.7.5 *Post-conditions***

The user is now a member of *Hangout*.

## **2.2.8 Use Case UC8**

### **2.2.8.1 *Objective***

Join/Leave Event Server

### **2.2.8.2 *Priority***

Medium

### **2.2.8.3 *Actors***

End-User

#### **2.2.8.4 Pre-conditions**

User joins event.

#### **2.2.8.5 Post-conditions**

User is added to a chat with other users that joined the same event. User can also leave or mute the chat.

### **2.2.9 Use Case UC9**

#### **2.2.9.1 Objective**

List Previous Events

#### **2.2.9.2 Priority**

Low

#### **2.2.9.3 Actors**

End-User

#### **2.2.9.4 Pre-conditions**

User is at their home page.

#### **2.2.9.5 Post-conditions**

User can see previous events they participated in.

### **2.2.10 Use Case UC10**

#### **2.2.10.1 Objective**

Manage Account

#### **2.2.10.2 Priority**

High

#### **2.2.10.3 Actors**

End-User

#### **2.2.10.4 Pre-conditions**

User is logged in and in their home page.

#### **2.2.10.5 Post-conditions**

User account has been updated as per their requirements.



## **2.2.11 Use Case UC11**

### **2.2.11.1 *Objective***

List Friends

### **2.2.11.2 *Priority***

Low

### **2.2.11.3 *Actors***

End-User

### **2.2.11.4 *Pre-conditions***

### **2.2.11.5 *Post-conditions***

## **2.2.12 Use Case UC12**

### **2.2.12.1 *Objective***

Add Friends

### **2.2.12.2 *Priority***

Low

### **2.2.12.3 *Actors***

End-User

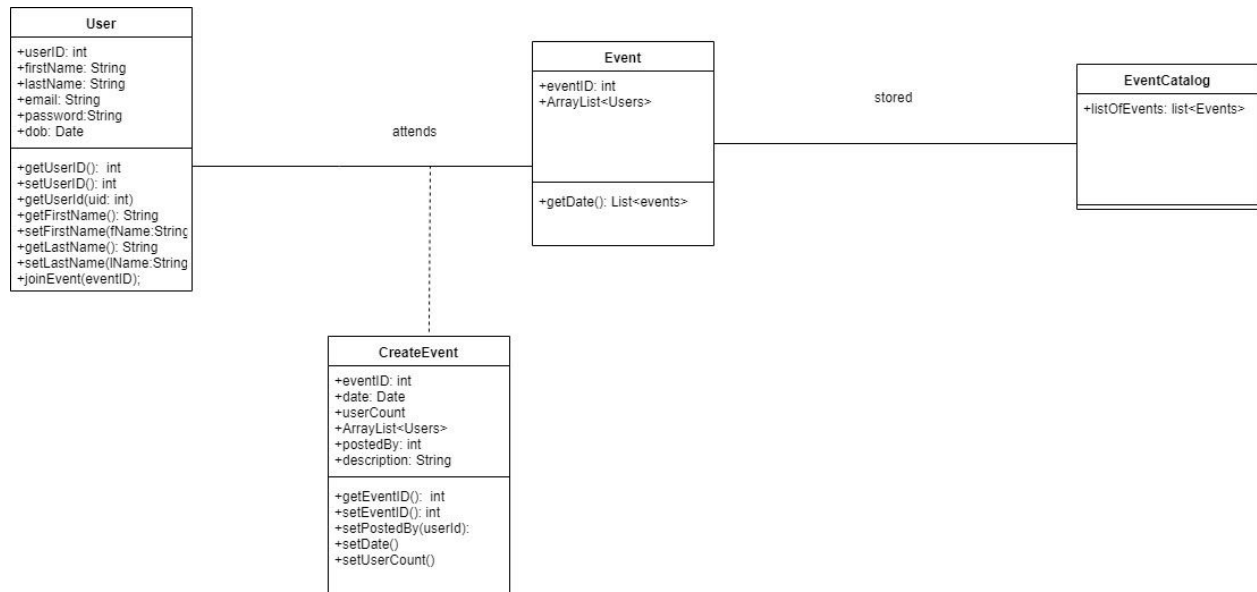
### **2.2.12.4 *Pre-conditions***

User has finished an event.

### **2.2.12.5 *Post-conditions***

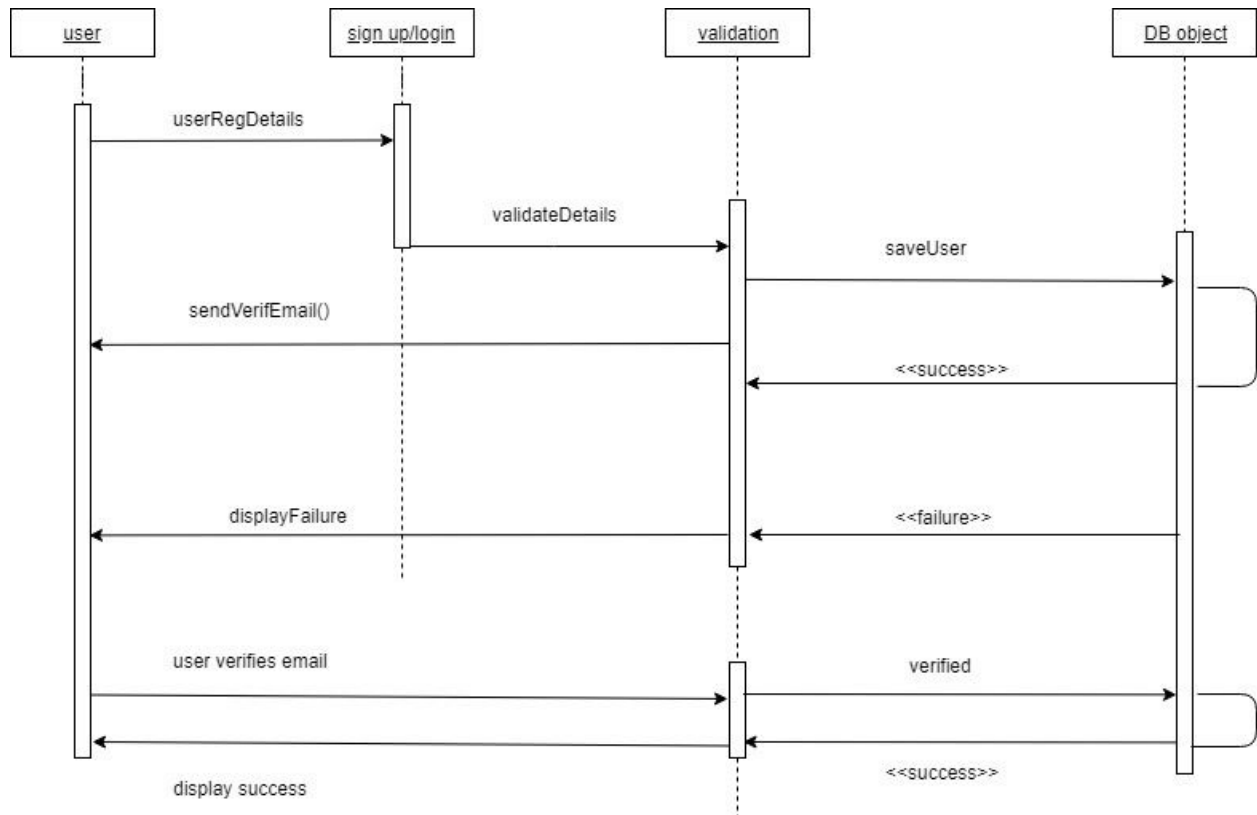
User can add other Users from past events to friends list.

## 2.3 Class Diagram

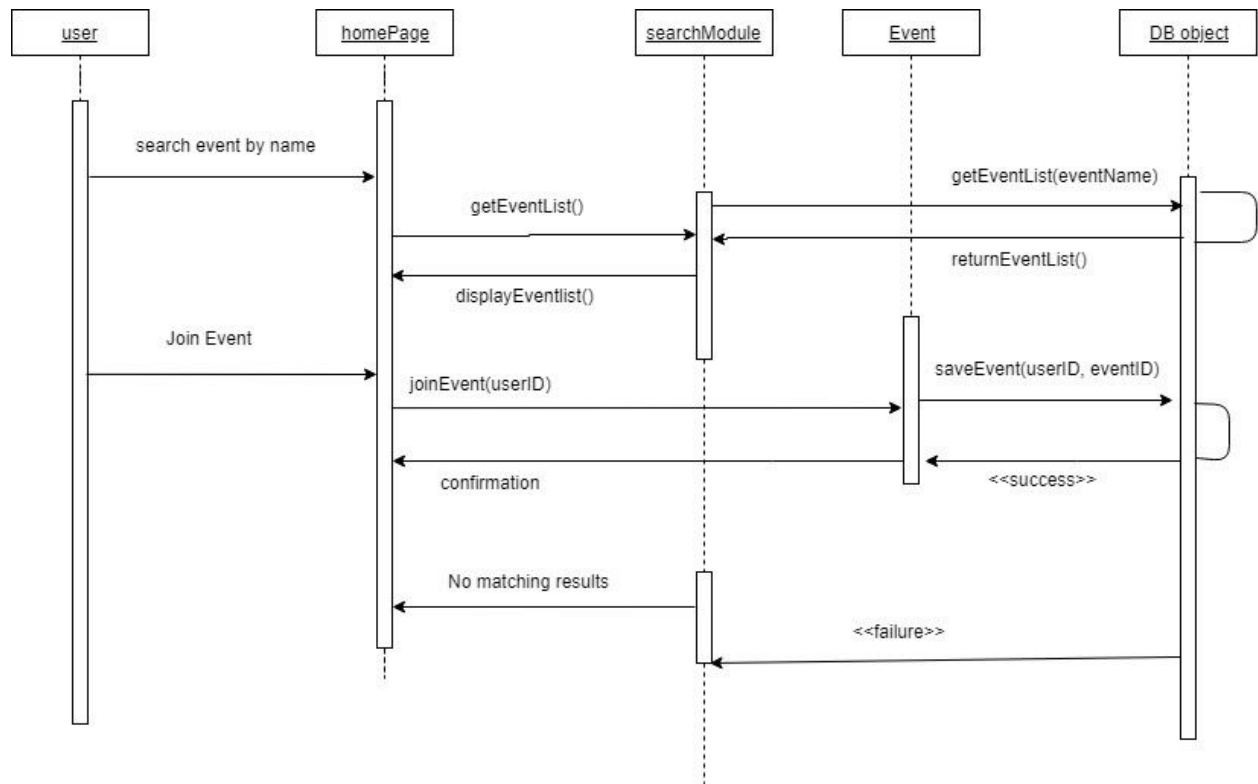


## 2.4 Sequence Diagrams

### 2.4.1 Registration



## 2.4.2 Search for Event



# Analysis

## 3.1 Tradeoff analysis

Front end	Pros	Cons
<u>React</u>	Familiarity, easy to learn, Fast, supports server-side rendering, Functional programming	Less standardized, Less class based, Mixes templating with JSX logic
Angular	Supports Typescript, prebuilt npm libraries, One way data binding	Variety of structures, slower than others
Vue	Adaptable, offers strong integration tools, allows for large templates, low weight	Small market share means finding resources is harder. Less global experience as well as team experience.

Backend	Pros	Cons
<u>Node</u>	Non-blocking I/O, single language, Flexible, familiarity, JSON focused, speed	Single threaded, Complexity
PHP	Massively popular and well supported, supports relational databases	Slower, combines html with it resulting in confusion, not component modular
Java	Super familiar, powerful, cross platform	Most server plugins require payment
Linode (virtual server)	affordable, transparent, scalable, reliable, full access to server, great customer service w/ phone line support, predictable pricing, open cloud (no vendor lock in), IP address of virtual server does not change	only supports Linux operating systems
<u>Express</u>	most popular web framework on NPM, provides simple user authentication, allows for login using social media, opensource	single threaded framework, poor scalability

\* Options that were underlined were our choices to proceed development with for the *Hangout* webapp

## Database Trade-off Analysis

Database	Pros	Cons
MySQL	<ul style="list-style-type: none"><li>• We have prior experience with this DB</li><li>• It's available for free.</li><li>• It offers a lot of functionality even for a free database engine.</li><li>• There are a variety of user interfaces that can be implemented.</li><li>• It can be made to work with other databases, including DB2 and Oracle.</li></ul>	<ul style="list-style-type: none"><li>• Time-consuming to set up</li><li>• Support not available in free version.</li></ul>
MongoDB	<ul style="list-style-type: none"><li>• It's fast and easy to use.</li><li>• The engine supports JSON and other NoSQL documents.</li><li>• Data of any structure can be stored and accessed quickly and easily.</li><li>• Schema can be written without downtime.</li></ul>	<ul style="list-style-type: none"><li>• SQL is not used as a query language.</li><li>• Tools to translate SQL to MongoDB queries are available, but they add an extra step to using the engine.</li><li>• Setup can be a lengthy process.</li><li>• Default settings are not secure.</li></ul>
Microsoft SQL Server	<ul style="list-style-type: none"><li>• It is very fast and stable.</li><li>• The engine offers the ability to adjust and track performance levels, which can reduce resource use.</li><li>• You are able to access visualizations on mobile devices.</li><li>• Works very well with other Microsoft products.</li></ul>	<ul style="list-style-type: none"><li>• Resource wasting</li><li>• Many individuals have issues using the SQL Server Integration Services to import files.</li></ul>
PostGRE SQL	<ul style="list-style-type: none"><li>• This database management engine is scalable and can</li></ul>	

	handle terabytes of data. <ul style="list-style-type: none"> <li>• It supports JSON.</li> <li>• There are a variety of predefined functions.</li> <li>• A number of interfaces are available.</li> </ul>	
--	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--

## Database Chosen: MongoDB

We chose to work with this database for now because we didn't find the lack of SQL to be a big deal. We will use this to take advantage of the Mongoose Express middleware.

## Architectural Pattern Tradeoff Analysis

Listed below are some of the architectural patterns we look to employ for *Hangout*. As the app becomes more complex, different problems might require a different pattern. Where we would plan to implement the pattern is written inside the parenthesis.

Architecture Pattern	Pros	Cons
Layered (Front-End)	<ul style="list-style-type: none"> <li>• Standardization is easier</li> <li>• Changes can be made within layer</li> <li>• Lower layer can be used by different higher layers</li> </ul>	<ul style="list-style-type: none"> <li>• Not universally applicable</li> <li>• May have to skip layers in certain situations</li> </ul>
Flux (Front-End Implementation)	<ul style="list-style-type: none"> <li>• Unidirectional Data flow</li> <li>• Centered on react</li> <li>• 4 components</li> </ul>	<ul style="list-style-type: none"> <li>• Restricted to front end</li> </ul>
Client - Server (Full Stack)	<ul style="list-style-type: none"> <li>• Standard web app model</li> <li>• reliable</li> </ul>	<ul style="list-style-type: none"> <li>• Requests typically handled in separate threads on the server</li> <li>• Intra-process communication causes overhead as different clients have different representations</li> </ul>

Model View Controller (Full Stack Implementation)	<ul style="list-style-type: none"> <li>• Multiple views possible for same model</li> <li>• Can be disconnected or connected at run time</li> </ul>	<ul style="list-style-type: none"> <li>• Increases complexity</li> <li>• Can lead to unnecessary updates</li> </ul>
Event-Bus (full stack)	<ul style="list-style-type: none"> <li>• Easy connections to publishers, subscribers, and connections</li> <li>• Effective for highly distributed applications</li> </ul>	<ul style="list-style-type: none"> <li>• Scalability is a problem</li> <li>• All messages travel through the same event bus</li> </ul>
Peer to Peer (specifically for messaging)	<ul style="list-style-type: none"> <li>• Supports decentralized computing</li> <li>• Robust</li> <li>• Scalable</li> </ul>	<ul style="list-style-type: none"> <li>• No guarantee of quality of service</li> <li>• Can't guarantee security</li> <li>• Performance depends on the number of nodes</li> </ul>
Master-slave (Full Stack)	<ul style="list-style-type: none"> <li>• Efficient delegation</li> <li>• Accuracy</li> </ul>	<ul style="list-style-type: none"> <li>• Isolated slaves; no shared state</li> <li>• Latency too high</li> </ul>

## Architecture to be implemented: Flux (front-end)/MVC (back-end)

We chose to work with the Flux Architecture pattern for the front-end because it's currently being used by Facebook, a site that we are trying to model *Hangout* after. It's an architecture/pattern that allows us to control the flow of data.

We will proceed to model our back-end in the Model View Controller architecture. Since data flow is already rigid in the back end, MVC is the standard choice for us to model our data.

# Machine Learning

## 3.1 Business Needs

The business purpose of the machine learning model is to support the application. It is meant to provide an edge to competitors, and not deviate focus from the product. Its primary function is illustrated in user feeds, determining what events shown are most likely to be attended or liked by the individual.

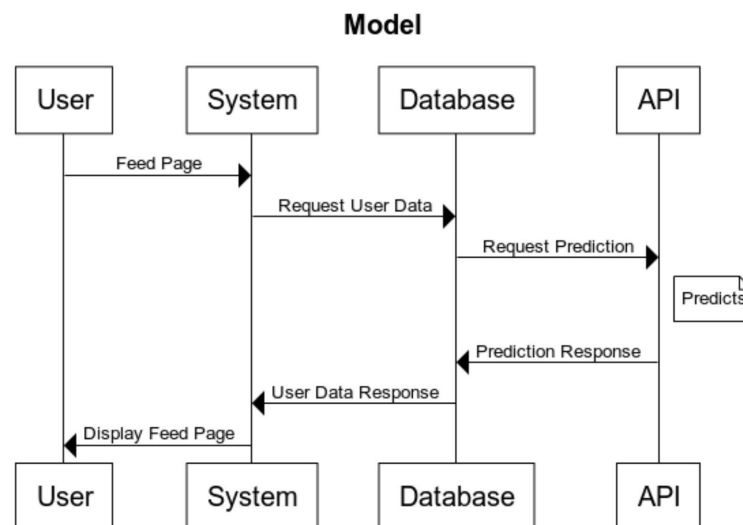
Model training needs a label for each of the interests on the application. It changes over time as users discover more interests to hang out.

### What is the benefit to your business?

Upon additional consideration, the team clarifies the model is implemented to be at pace, but different, from competitor sites. Our model is similar, but operates slightly different to give our users a unique experience from other sites. It is further elaborated in the next question.

### What is the benefit to stakeholders?

As it is understood, the stakeholders are our users. Where it is at the moment, the model is primarily based on the likes of people utilizing the site (as discussed in class, the focus was implementation and tuning as time permits). The benefit to users is illustrated in personal feeds, recommending events they otherwise are not likely to see on competitor sites because of the goal of our model: similar, but different operations.



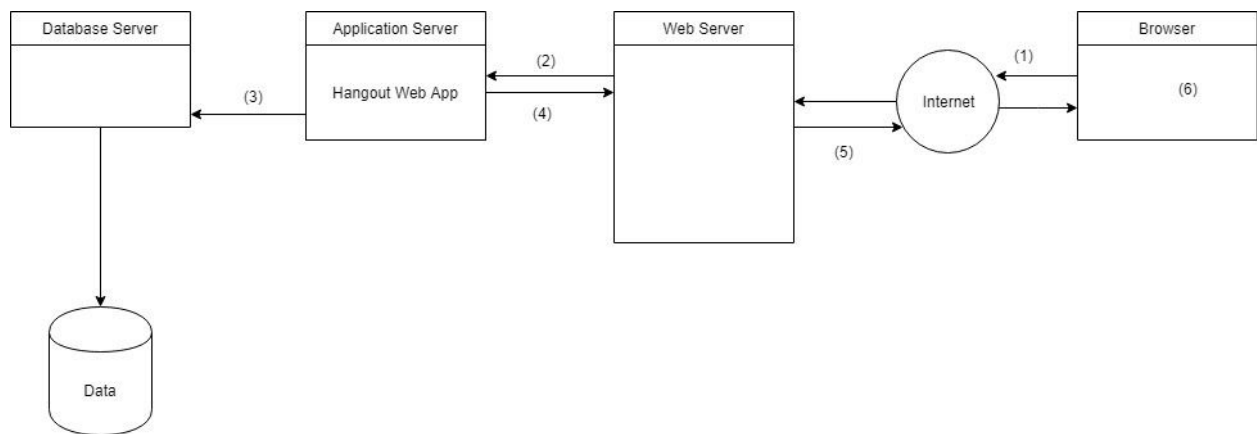
## 3.2 Training Data

Data features at the current training (and testing) build iteration are the seven.



MMO  
VS  
Volleyball  
Tennis  
Swimming  
Jogging  
Water Polo

### 3.3 Machine Learning as a Web API



The team is attempting to deploy a web API with Flask. It will be written in Python.

### 3.4 Model Tradeoff

Decision Tree	Linear Regression
<ul style="list-style-type: none"> <li>+ It is more malleable by the application standards. Labels (and targets) change, and the tree needs to react.</li> <li>+ Efficient for the standards of the application. Data can be sent to the model and a response is received after computation a computer deems simple.</li> </ul>	<ul style="list-style-type: none"> <li>+ Clearer representation of correlation (not necessarily needed in the product).</li> <li>- It is not as malleable or efficient for the application. The target label commonly changes, and linear regression performs a number of steps per change.</li> </ul>

A supervised, classification decision tree. It is a prediction algorithm based on users and implemented in binary. On means the user likes or liked in the past an interest, off is default or disliked.

An important note is the machine learning model is not meant to reach perfect accuracy. As it is deployed in a subjective setting (and much like a mutation in genes), presenting the user with a random interest at some point is accepted. An individual can like or dislike as they please, and the model consequently retrieves additional data.

## Hyperparameter Optimization

As it is a decision tree, it is more likely to overfit noisy data. The probability of overfitting noise is said to increase in a deep tree. Exploring pruning as a possible solution.

Efficiency and malleability are the performance metrics for our machine learning capabilities. The model is intended to add features without large distractions or select a target feature quickly. Additionally, measures of success likely entails continued user enablement or feedback. Indicating whether the user attended or liked the recommended event rather than dismissing it. Perhaps if they enabled an option to disable catering feeds to their liking.

Our machine learning capabilities meet the business needs in terms of metrics. It is designed for the webapp to continue operating despite any of the model's own issues (i.e. server down). It is implemented as taught at the working capability as any further iterations, if time allows, fine tunes such capacities.

## 3.5 10 Steps

### 1. What are the input and the output of the model (X and y)?

A note for the model: it is periodically retrained and retested, so the example case is referred to  $E$ . X is the dataset of likes per user ( $E$ : MMO, VS, Tennis, Volleyball, Swimming, and Water Polo). Y is the predicted target variable ( $E$ : Jogging).

In the instance of  $E$ , the question is if the model recommends an event labelled Jogging to a user with a defined set of interests in MMO, VS, Tennis, Volleyball, Swimming, and Water Polo.

### 2. Where did you get your data?

The data is created manually primarily by real instances (e.g. a friend might indicate liking Volleyball and Swimming.)

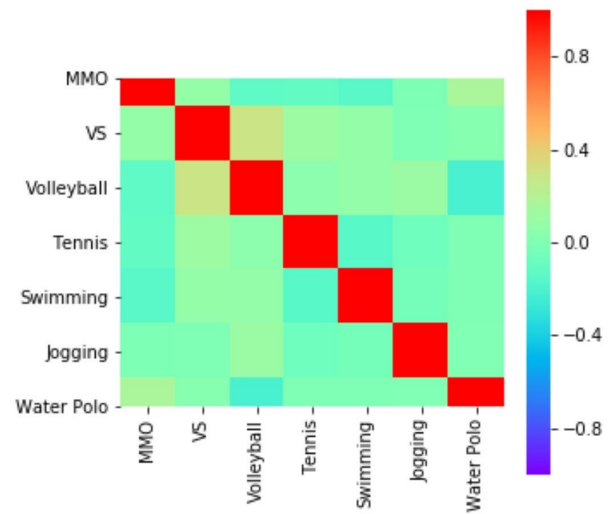
### 3. What does your data look like?

A CSV and heatmap.

```

1 MMO,VS,Volleyball,Tennis,Swimming,Jogging,Water Polo
2 1,1,0,0,0,0,0
3 0,0,1,1,0,1,1
4 0,0,0,0,1,1,0
5 1,0,1,1,0,0,1
6 0,1,0,1,0,1,1
7 0,0,1,0,1,1,1
8 0,0,1,1,1,1,0
9 1,0,1,0,0,1,0
10 0,1,1,1,0,0,1
11 0,0,1,0,0,1,0
12 0,0,0,1,0,1,1
13 0,1,1,1,1,0,0
14 1,0,0,0,0,0,1
15 1,1,1,1,0,1,0
16 0,1,1,1,0,1,1
17 0,0,0,1,1,1,0
18 1,0,0,0,0,0,1
19 1,0,0,0,0,1,0
20 1,0,0,0,1,0,1

```



#### 4. Is there any preprocessed data?

It does not seem to be a necessity for the model at its current build. A 1 is tacked into a user's data set when a feature is liked, a 0 is default for no missing values.

An important note: the team has considered too many 0s might influence the model (as it indicates a disinterest), so it was intended the user selects at least three interests to place 1s into their sets when an account is created.

#### 5, 6, and 7. Discussed above.

#### 8. What is the accuracy expectation and error?

Accuracy expectation is 74.7119. It is somewhat of an expected value because the team expects the current build to be wrong sometimes. The purpose of the model is to recommend based on the people in the same site to attempt new events and meet more people (e.g. one person liking Tennis and Water Polo does not indicate every person liking Tennis likes Water Polo when it recommends it).

#### 9. What are the results?

No offense is intended, but it appears the model is building patterns quite nicely. According to these predictions, interesting observations can be made in support to some correlations. Users interested in activities at home tend to sway towards games or solitude (MMOs, Vs, Jogging, and Swimming). The CSV made an interesting observation between the similarities of Volleyball and VS games (both are team games against an opposition).

#### 9. Monitor

A clarification: the current model build entails periodic training and prediction. More details below.

## Explain the deployment architectural decision.

The team decided on an API for two reasons. It was primarily to use the opportunity and environment to learn. In attempting to deploy as an API, the team's learned a bit more about the creation and utilization of APIs in programs in general.

More importantly however, it was because the team is aware the model is in need of periodic training and a change in variables. It might be easiest for the process to query the database and send the information as a whole (it might additionally be a bit cleaner).

## Where is Flask used?

Flask is a microframework used to build websites and APIs in Python. The team uses it to build our API, persisting the model for programs to access. Through it, the model imports methods such as jsonify and request.